The Beagle, Records of the Northern Territory Museum of Arts and Sciences, 1993 **10**(1):75-86

NEW RECORDS AND NEW SPECIES OF PARONELLID AND CYPHODERID COLLEMBOLA FROM THE INDONESIAN REGION, MAINLY SULAWESI.

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ABSTRACT

Sixteen species of paronellid and four species of cyphoderid Collembola are here recorded from northern Sulawesi for the first time. Three species of paronellid are new, *Callyntrura (Istanaphysa) incolorata* sp. n., *Callyntrura (Istanaphysa) sulawesica* sp. n. and *Bromacanthus wallacei* sp. n. The fauna of northern Sulawesi appears to have greatest affinities with that of Borneo.

KEYWORDS: Collembola, Sulawesi, Paronellidae, Cyphoderidae, new species.

INTRODUCTION

The collembolan fauna of Sulawesi (formerly Celebes) is very poorly known and until recently only one species, *Salina celebensis* (Schäffer), was known from the island. The first collection of Collembola from northern Sulawesi was made during Project Wallace, the Royal Entomological Society of London's year-long expedition in 1985. From this collection, Yoshii and Suhardjono (1989) recorded three paronellid species, *Salina greensladeae* Yoshii and Suhardjono, *Callyntrura (Borneaphysa) gapudi* Yoshii and *Bromacanthus setigerus* (Börner), while Mari Mutt (1987) and Da Gama (1988) have published on the Orchesellinae (Entomobryidae) and on *Xenylla* Tullberg (Hypogastruridae) respectively, from the same collection. Blackith and Disney (1988) recorded two species, one identified as *Salina celebensis* and the other identified to genus only, from aerial Malaise traps run during the expedition.

Currently the fauna of Sulawesi is being studied by Deharveng (1986, 1987a, b) who lists a number of genera from caves in southern Sulawesi and other terrestrial habitats represented by undescribed species. Suhardjono (1989) lists all species known from Indonesia and adjacent regions.

This paper describes the Paronellidae and Cyphoderidae collected on the Project Wallace expedition, and is one of a series of regional studies by the senior author (Yoshii 1980, 1981, 1982, 1983, 1987, 1989) of these families in the Orient and south-west Pacific. The family Paronellidae is highly diverse in the tropical rain forests of Asia and sixteen species of paronellid and four species of cyphoderid are recorded here from northern Sulawesi. For the most part, collections come from field work carried out in the Dumoga-Bone National Park, 155 km west of Manado. Most of the paronellids recorded here were collected by hand, either by beating, sweeping or searching leaf litter in rainforest or plantations; others were collected in pitfall traps. Many species were rare in leaf litter, as evidenced by hand sifting and funnel extraction.

The system of setal nomenclature followed here is that given in Yoshii (1981, 1982 and 1983). All material is deposited in the South Australian Museum collections unless specified otherwise.

Abbreviations. *Institutions*: **MZB**, Museum Zoologicum Bogoriense, Bogo, Java, Indonesia; **SAMA**, South Australian Museum, Adelaide, Australia.

Collector: **PG**, P. Greenslade.

Morphology: **ant**, antenna; **abd**, abdomen; **abd I, II, III, IV, V, VI**, abdominal segment I, II,

III, IV, V, and VI; **man**, manubrium; **max**, maxilla; **s.s.-like seta**, sensory sensillum-like seta (bothriotrix); **th**, thorax; **th II, III**, thoracic segment II, III.

SYSTEMATICS

A check list of species from Sulawesi follows. A full synonymy for each species is given in the recent checklist for Indonesia and adjacent regions by Suhardjono (1989).

Family Paronellidae

1. *Salina borneensis* Yoshii, 1981
2. *Salina celebensis* (Schäffer, 1898)
3. *Salina cingulata* (Handschin, 1925)
4. *Salina greensladeae* Yoshii & Suhardjono, 1989
5. *Salina insignis* Handschin, 1928
6. *Salina* sp. A
7. *Salina* sp. B
8. *Callyntrura (Istanaphysa)* sp. cf. *apiana* Yoshii, 1981
9. *Callyntrura (Borneaphysa) gapudi* Yoshii, 1983
10. *Callyntrura (Istanaphysa) incolorata* n. sp.
11. *Callyntrura (Istanaphysa) mostynensis* Yoshii, 1981
12. *Callyntrura (Istanaphysa) sulawesica* n. sp.
13. *Callyntrura (Istanaphysa) sumatrana* (Oudemans, 1890)
14. *Microparonella annulicornis* (Oudemans, 1890)
15. *Bromacantlus setigerus* (Börner, 1906)
16. *Bromacantlus wallacei* n. sp.

Family Cyphoderidae

17. *Cyphoderus javanus* Börner, 1913
18. *Serroderus hozawai* (Kinoshita, 1917)
19. *Serroderus* cf. *sabalanus* (Yoshii, 1980)
20. *Mimoderus saikehi* Yoshii, 1980

Salina borneensis Yoshii
(Fig. 1A-H)

Salina borneensis Yoshii, 1981: 47.

Material examined. (4 specimens); 1, Dumago-Bone N.P., O°34'N 123°54'E, 20-25 September 1985, coll. PG; 2, Toraut River bank, O°34'N 123°54'E, in garden, 20-25 April 1985, coll. PG; 1, Gunung Muajat, 1760 m, O°45'N 124°25'E, 16 September. 1985 coll. J. Huijbregts.

Description. Body length up to 2.4 mm. Colour almost white, but the lateral margin of tergites suffused with bluish tinge of pigment (Fig. 1A). Antennae, legs and abd V, VI diffusely dark. Ventral side of the body with scattered black pigment in spots. Ratio ant: head 2:1. Eyes 8+8, rather poorly pigmented, each cornea separately visible. Labrum (Fig. 1B) with setae 4/5, 5, 4, prelabrals barbed, labral margin with four tubercles in a transverse row. Outer max lobe (Fig. 1C) with setae 2/II+3, basal seta of the papilla pointed, not blunt. Setae of labial base as M-E/LL, with R absent. Legs elongate, (Fig. 1D), unguis small, with one paired inner proximal tooth. Unguiculus strongly truncate. Tenent hair about 2 times the length of unguis, spatulate distally and slightly ciliated. Trochanteral organ with about 50 spiny setae arranged in a quadrangle. Ventral tube anteriorly (Fig. 1F) with 3+3 large, barbed setae plus about 7+7 feeble, ciliated, more proximal setae. Posterior side (Fig. 1G) with about 6+6 feeble, ciliated setae plus 2+2 spiny, more proximal pegs. Lateral flap with larger smooth and smaller ciliated setae. Terminal tubule smooth. Furca with man:dens ratio as 1:1.5. Dens without any modified setae, but with a large distal vesicle. Muero (Fig. 1E) subequally tridentate.

Head with a pair of frontal spines and 2+2 macrosetae on vertical area, but others reduced and small. Cervical setae not differing much from the adjacent secondary setae. Chaetal pattern of trunk strongly variable, more setae in larger (2.3 mm) individuals (Fig. 1H) while in small individuals (2.0 mm), fewer; anterior group of th II always with 3+3 forming an L shape and abd II with setae arranged according to formula s/2/s/2.

Remarks. When the species was described, the mouth parts were not figured. Here a full description based on Sulawesi specimens is given so that the maxillar palps of *S. borneensis* and *S. pallens* can be compared with those of other *Salina*, such as that from Kei Island in the Moluccas, which have fewer macrosetae on the trunk. Species in this group seem to be widely distributed in the islands of Indonesia (Yoshii and Suhardjono 1989).

The species name was spelt *borneesis* in the original description (Yoshii 1981:47) but the figure was labelled *borneensis* (p. 48). The author's intention is clear and *borneensis* is accepted as the correct specific epithet.

Extralimital distribution. Borneo.

Salina celebensis (Schäffer)

Cremastocephalus celebensis Schäffer, 1898: 407.
Salina celebensis - Yoshii 1959: 42.

Material examined. Fifty-five specimens: 52 (MZB), Dumoga-Bone N.P., 200-300 m, 0°34'N 123°54'E, lowland forest, 27 September - 6 Oetober 1985, coll. PG; 1, Dumoga-Bone N.P., 0°34'N 123°54'E, 6 October 1985, coll. PG; 1, Toraut River bank, 0°34'N 123°54'E, 8 September 1985, coll. PG; 1, Lake Mooat, 15 km east of Kotamobagu, 1080 m, 0°45' 124°25', 11 September 1985, coll. PG.

Remarks. Specimens from Sulawesi agree well with the description of *S. celebensis*. The chaetal pattern is as described by Yoshii (1983).

Extralimital distribution. Singapore, Malay Peninsula, Java, Sumatra, Borneo.

Salina cingulata (Handschin)

Cremastocephalus cingulatus Handschin, 1925: 248.
Salina cingulata - Yoshii 1983: 20.

Material examined. Three specimens: 1, Dumoga Bone N.P., 2nd waterfall, Tumpah River, 0°35'N 123°54'E, lowland rainforest, 25-28 September 1985, coll. D.Polhemus; 2, Lake Mooat, 15 km east Kotamobagu, 1080 m, 0°45' 124°25', near stream, 30 September - 2 Oetober 1985, coll. PG.

Extralimital distribution. Malaysia, Sumatra.

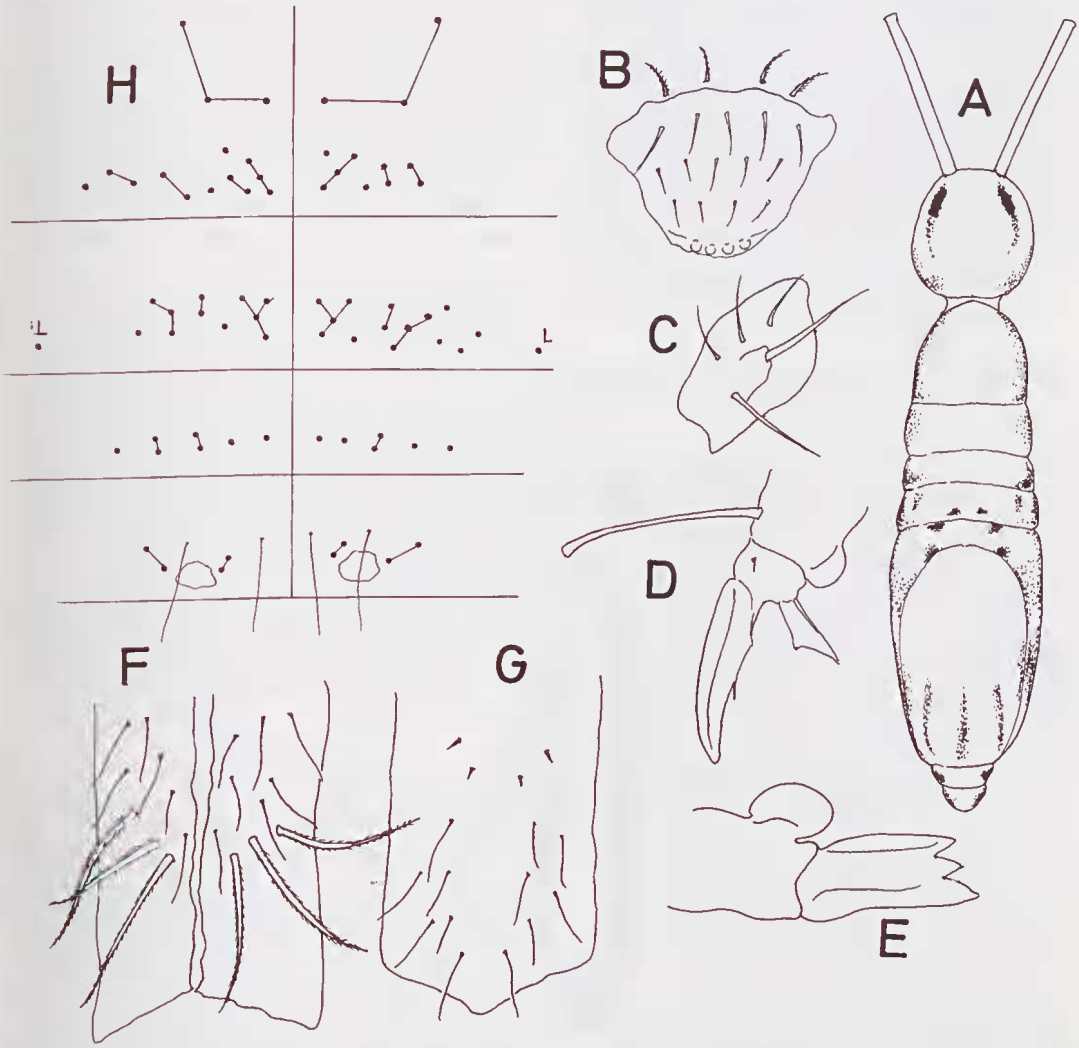

Fig. 1. *Salina borneensis* Yoshii: **A**, habitus; **B**, labrum; **C**, outer maxillary lobe; **D**, hind claw; **E**, mucro; **F,G**, ventral tube (anterior and posterior view); **H**, macrochaetal pattern of the trunk.

Salina greensladeae **Yoshii and Suhardjono**
Fig. 2A-H

Salina greensladeae Yoshii and Suhardjono, 1989: 70.

Type material. LECTOTYPE - here designated - SAMA I 22603, Dumoga-Bone N.P., 200-300 m, lowland forest near Toraut River, 0°34'N 123°54'E, 13-20 September 1985, coll. PG;

PARALECTOTYPES - (4), 3, same locality and date; 1 (MZB), same locality, banks of Toraut River, 0°34'N 123°54'E, 18-20 September 1985, coll. PG.

Description. Body length up to 2.4 mm., ground colour brownish white, with deep purple pigment patches (Fig. 2A). Broad, lateral band from the antennal base, through eye field, to the distal abdomen covering whole of abd VI. Antennal segments pigmented near distal end and laterally, legs with faint pigment at the middle of tibiotarsus and near distal end of femur. Furca wholly pale. Eyes 8+8, poorly pigmented, each cornea separately visible, but G, H smaller than others. Labral setae 4/5, 5, 4 (Fig. 2B), prelabrals barbed, labral margin with four tubercles. Outer maxillary lobe (Fig. 2C) with setae 2/II+1, basal seta of papilla slightly modified, straight and finely blunt at apex, two proximal setae barbed. Setae of labial base (Fig. 2D) as M-E/LL, R being absent. Legs elongate, unguis small, with one pair of inner proximal teeth, unguiculus truncate. Tenent hair very long, spatulate apically and almost smooth for all its length. Trochanteral organ (Fig. 2E) with about 20 spinules, rather sparsely distributed. Ventral tube anteriorly with 3+3 large, barbed setae and about 8+8 finely toothed setae more proximally. Posteriorly ventral tube with only about 6+6 ciliated setae, without proximal peg. Furca with ratio man:dens 1.0:1.3, without spinose setae, but with a well developed dental vesicle. Mucro (Fig. 2F) tridentate of a characteristic form. Genital field of male (Fig. 2G) similar to other species of the genus. A pair of frontal spines present on the head, vertical group represented by 2+2 macrosetae, others small. Cervical setae present, almost smooth. Macrochaetotaxy of the trunk (Fig. 2H) identical to that of *S. celebensis*.

Remarks. Only a brief description of this species was given by Yoshii and Suhardjono

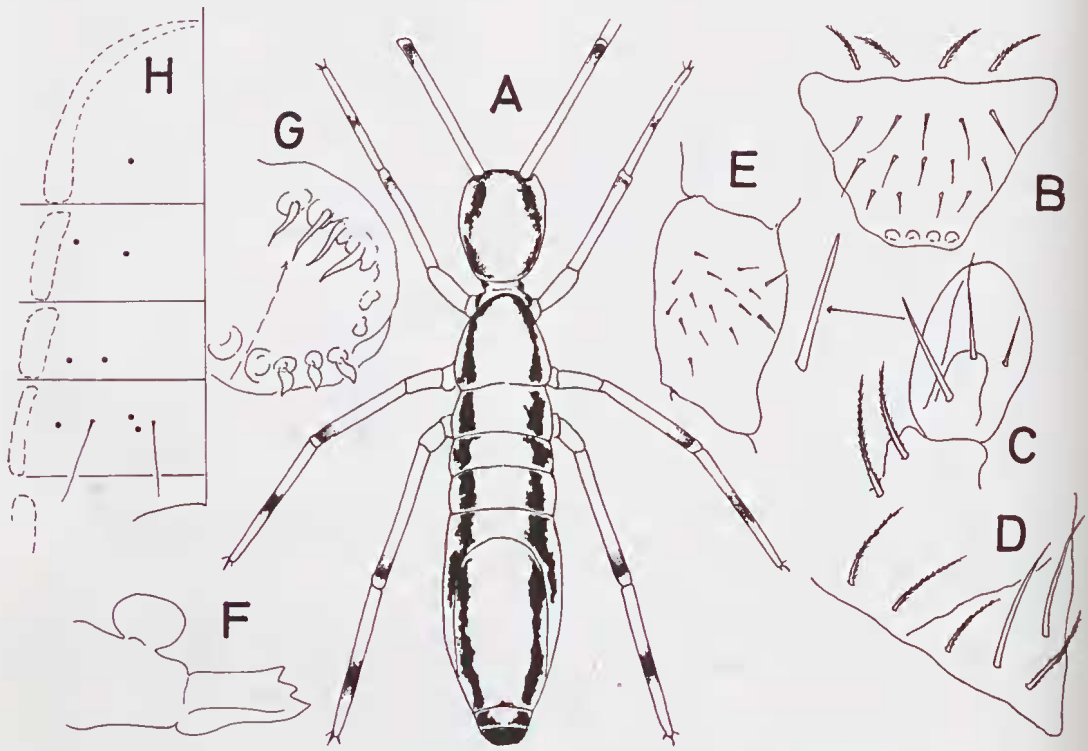

Fig. 2. *Salina greensladeae* Yoshii and Suhardjono: **A**, habitus; **B**, labrum; **C**, outer maxillary lobe; **D**, labial base; **E**, trochanteral organ; **F**, mucro; **G**, male genital orifice; **H**, macrochaetal pattern of the left side of body.

(1989). *Salina greensladeae* has a similar pattern of abdominal macrochaetae to *S.celebensis*. However, there is no intermediate form between them in the colour pattern.

There is some variation within *Salina greesladeae* in the form of the basal seta of the outer maxillary lobe and number of its peripheral setae as well as in the smooth tenent hair and absence of pegs from the ventral tube.

Extralimital distribution. None.

Salina insignis (Handschin)

Cremastocephalus insignis Handschin, 1928: 259.

Salina insignis - Goto 1955: 41.

Material examined. Four specimens: 4, Dumoga-Bone N.P., 0°34'N 123°54'E, 18-20 September 1985, coll. PG.

Remarks. This species was redescribed by Yoshii (1983).

Extramlimital distribution. Malay Peninsula, Borneo.

Salina sp. A

Material examined. Three specimens: 3, banks of Molibagu River, 5 km north of Molibagu, south coast of North Sulawesi, 0°27'N 123°59'E, 19 September 1985, coll. PG.

Remarks. This is possibly a new species. The colour pattern is similar to *S. greensladeae*, having paired longitudinal bands on the trunk. But, in contrast to *S. greensladeae*, the band is brownish in colour. The chaetal pattern is similar to *S. borneensis*, so that it has more macrosetae on the trunk than *S. greensladeae*. Setae of the outer maxillary lobe have not been examined owing to the poor state of the specimens.

Extralimital distribution. None.

Salina sp. B

Material examined. One specimen: 1, Lake Mooat, 15 km east of Kotamobagu, 1080 m, 0°45' 124°25', in coffee plantation, 21 October 1985, coll. PG.

Remarks. The species is identical to *S. celebensis* in morphological details including the macrochaetotaxy of the body, but there are patches of dotted brownish pigments laterally, which may indicate that this is a different species.

Extralimital distribution. None.

Callyntrura (Istanaphysa) cf. *apiana* Yoshii

Callyntrura apiana Yoshii, 1981: 21.

Material examined. Two juveniles: 2, Dumoga Bone N.P., Toraut River nr dam, 0°34'N 123°54'E, leaf litter, 9 October 1985, coll. PG.

Remarks. From the setae of the labrum, this species may belong to *Istanaphysa,* but it cannot be definitely identified as the specimens are immature. The colour pattern is similar to *C. apiana* from Borneo.

Extralimital distribution. Borneo.

Callyntrura (Borneaphysa) gapudi Yoshii

Callyntrura gapudi Yoshii, 1983: 1.

Material examined. Six specimens: 4, Dumoga-Bone N.P., 1 km NW Toraut dam, 0°34'N 123°54'E, 14 October 1985, coll. PG; 1, same locality, 25 October 1985, coll. PG; 1, G. Rontemaro, 3200 m, coll. A. Whitten.

Remarks. Sulawesi specimens agree well in all respects with Philippine material from Luzon, Palawan (Yoshii 1983). Sometimes the distal end of the dens is inflated, but this is not the dental vesicle, since there is no space between the inflation and the end of the segment.

Extralimital distribution. Philippines.

Callyntrura (Istanaphysa) incolorata n. sp. (Fig. 3A-D)

Type material. HOLOTYPE - SAMA I 22605, Gunung Muajat, 1780 m, 0°45N 124°25'E, 16 October 1985, coll. J. Bruitgets.

PARATYPES - (43), 23 (MZB), same locality and date as holotype; 14, Lake Mooat, 15 km east of Kotamobagu, 1080 m, 0°45' 124°25', in coffee plantation, 21 October 1985, coll. PG.

Description. Totally brownish white except eyes and a pigmented frontal spot, with brownish scales and setae (Fig. 3A). Ant I-III with a small pigmented spot on distal end. Ant IV diffusely dark, other extremities quite pale. Ratio ant I:head 15:10. Eyes 8+8, black; Labrum with setae 4/5, 5, 4, the median three of the basal (p) row straight, blunt, prelabrals barbed. Margin with two small tubercles. Outer max lobe with setae as MRe/11, as usual in *Istanaphysa*. Legs including unguis, unguiculus and trochanteral organ, similar to other species in the subgenus. Ventral tube anteriorly with some brownish setae, the distal 3+3 much larger. Posterior face with smaller, but distinctly barbed

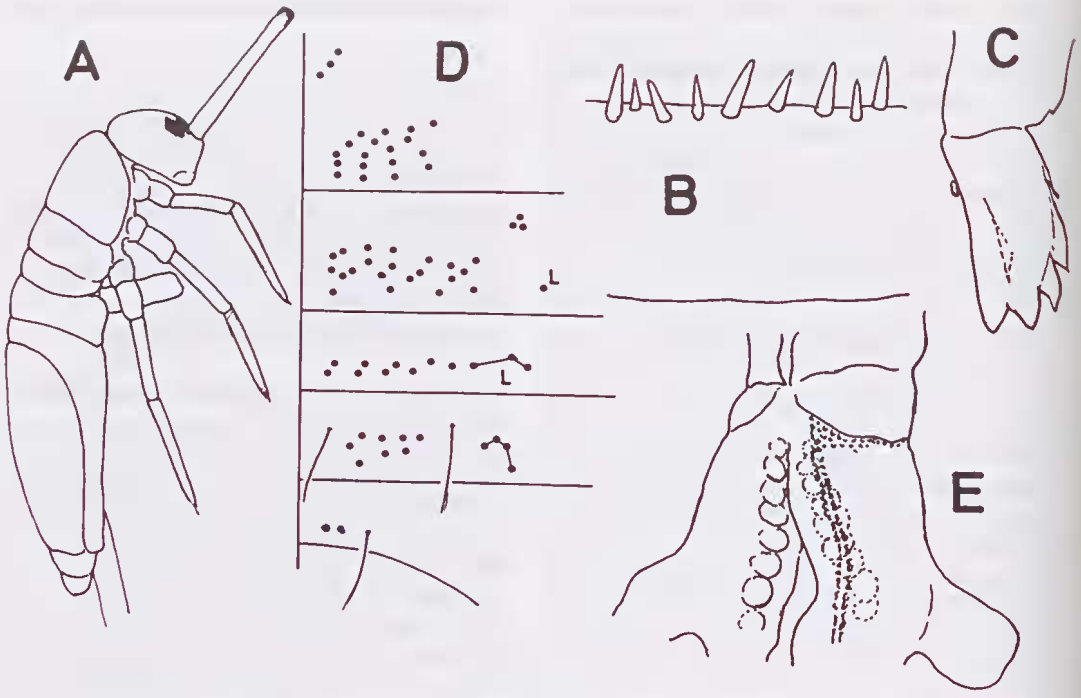

Fig. 3. *Callyntura (Istanaphysa) incolorata* n. sp.: **A**, habitus; **B**, dental spines; **C**, mucro; **D**, chaetal pattern of the right side of the body. *Callyntrura (Istanaphysa) sumatrana* (Oudemans): **E**, proximal part of the terminal tubule of ventral tube.

setae, but without s-like seta. Terminal tubule smooth. Furea with ratio man:dens 8:6. Manubrium ventrally with slender scales, dorsally with barbed setae. Dens bearing an irregular row of about 50 short spines (Fig. 3B) on its inner latcral side. Dental vesicle absent. Mucro (Fig. 3C) typically with six teeth. Macrochaetal pattern (Fig. 3D) similar to *C. sulawesica* sp.n. except that one L macrochaeta constant on th III. On abd IV median group of sctae is on one level and distal group is about 8+8.

Remarks. Since the species is near *C. sulawesica* sp. n. in various respects, it was assumed at first to be a pale form of this species, but there is no intermediate colour form between them. In addition, there is one L seta on th III. As in other groups of Entomobryomorpha, i.e. *Entomobrya, Seira* and *Salina*, the pale species arc diffieult to identify unless there are many specimens from various localities. This is one sueh case. In eolour pattern it looks superficially like *C. tarsata* (Börner, 1906) or *C. lombokiana* Yoshii and Suhardjono, 1989, but it is quite different in morphological detail.

Extralimital distribution. None.

Callyutrura (Istauaphysa) mostynensis Yoshii

Callyntrnra mostynensis Yoshii, 1981: 23.

Material examined. Three specimens: 3, Dumoga Bone N.P., 0°34'N 123°54'E, waterfall, rock waterholes, 13 September 1985, coll. D. Polhemus.

Remarks. The eolour pattern is the same as described for this species from Borneo (Yoshii 1981). It differs from *C. apiana* Yoshii in the presence of the longitudinal stripes on the anterior half of abd IV.

Extralimital distribution. Borneo.

Callyutrura (Istauaphysa) sulawesica n. sp.
(Fig. 4A-H)

Type Material. HOLOTYPE - SAMA I 22,604, Tapakulintang, N of Molibagu, 0°22'N 123°59'E, moss on rocks along stream, 15 September 1985, coll. D. Polhemus.

PARATYPES - (9); 6, SAMA, same locality and date as holotype; 4 (MZB), Lake Mooat near Kotamobagu, 1200 m, 0°45' 124°25'E, pitfalls in eoffee plantation, 21-23 October 1985, eoll. PG.

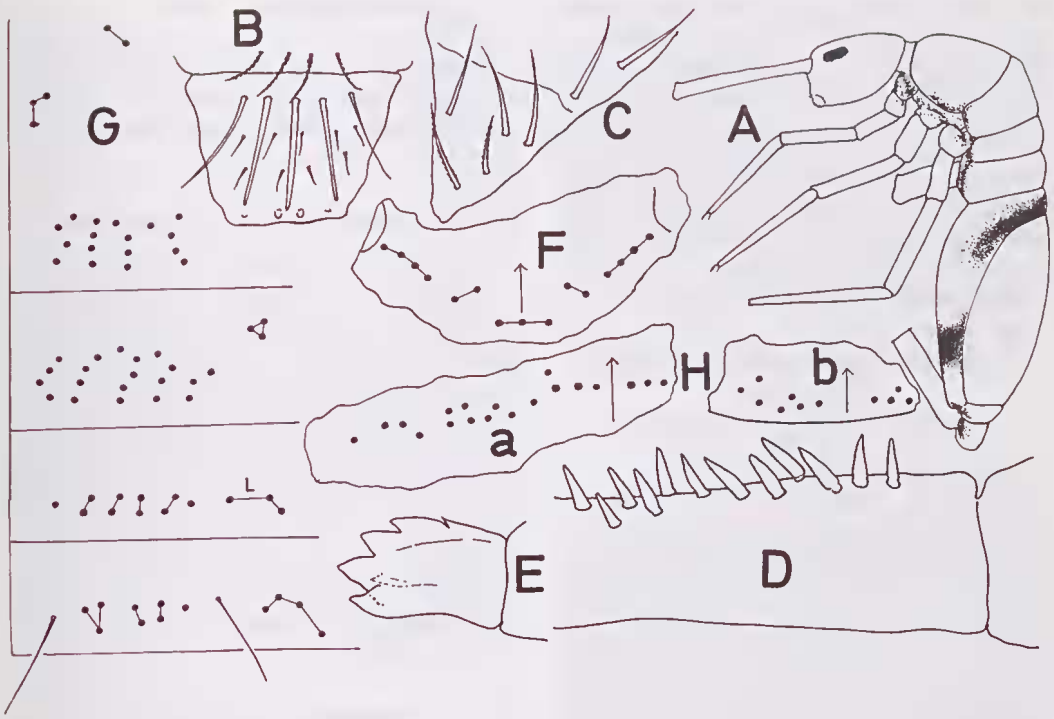

Fig. 4. *Callyntrura (Istanaphysa) sulawesica* sp. n.: **A**, habitus; **B**, labrum; **C**, labial base; **D**, dental spines; **E**, mucro; **F**, macrosetae of vertical area; **G**, ditto of right side of body; **H**, ditto of abd IV (a-median and b-posterior group).

Additional material. One, Dumoga Bone N.P., 1 km NW Toraut dam, 0°34'N 123°54'E, lowland rainforest, 25 October 1985, coll. PG; 2 juveniles, Toraut River bank near dam, 0°34'N 123°54'E, leaf litter, 9 October 1985, coll. PG; 25 specimens, (MZB), East Kalimantan, Wanariset, swamp forest, August 1980, coll. Y. Suhardjono.

Description. Body length up to 2.5 mm, ground colour brownish white, with a diffuse transverse band on posterior half of abd III and near the middle of the posterior extension of the same segment (Fig. 4A). Antennae, legs, furca and ventral tube quite pale, but lateral part of the trunk slightly darker. Ratio ant I: head diagonal 4:7. Labrum (Fig. 4B) with setae as 4/5, 5, 4, the median three of the first row straight and blunt, prelabrals barbed. Labral margin with 2+2 small tubercles. Outer max lobe with setae 2/II+3, proximal two barbed, seta of the basal papilla well developed, thick with blunt tip. Setae of labial base (Fig. 4C) as MRe/II. Eyes 8+8, subequally large and deep black. Legs with unguis and unguiculus normal for the genus. Trochanteral organ composed of about 50 spiny setae in a triangular arrangement. Ventral tube with many serrated setae, without s-like seta on posterior side, terminal tubule apparently smooth, without granulation. Furca ratio man:dens 5:8. Manubrium ventrally with many elongate, almost setose, scales. Those of the distal area almost like barbed setae, and broader, more scale-like, barbed setae found only on proximal part of the outer side. Dens also with the same type of scale-like setae. Dorsally, manubrium only with longer barbed setae laterally, dens also with setae of the same type, but also with an irregular row of 40-50 small, smooth spines (Fig. 4D) along the inner side. Dental vesicle absent. Mucro (Fig. 4E) rather short, with 6 teeth as normal. Chaetal pattern as in Fig. 4F-H, the vertical group with the full number. Anterior group of setae on th II 3, 2, 0, on th III 3, 0, 0, and abd I with L-1, L-2, L-3. Abd II setae s/8/s/4. Median group of setae on abd IV on same level, posterior group about 7+7.

Remarks. In the presence of spinules on the dens and the number of setae on abd II, the species is very similar to *Callyntrura (Istanaphysa) palawanica* Yoshii, 1983, but the ventral side of the trunk and antennae are not pigmented, the

transverse band of abd III is narrower and abd IV is not pigmented at all. The full number of macrochaetae (s/8/s/4) is present on abd II.

Among the species of the subgenus *Istanaphysa* Yoshii, 1981, known from Borneo, the Philippines and now from Sulawesi, the presence of dental spines and s/x/s/4 setae on abd II are common features, except in *C. vexans* Yoshii from Borneo, whose taxonomic position will be discussed in a later publication.

Extralimital distribution. Borneo.

Callyntrura (Istanaphysa) sumatrana (Oudemans)
(Fig. 3E)

Sira sumatrana Oudemans, 1890: 88.
Callyntrura (Batikphysa) sumatrana - Yoshii and Suhardjono 1989: 75.

Material examined. Nine specimens: 3, north of Molibagu, south coast of northern Sulawesi, 200 m, 0°22'N 123°59'E, 15 September 1985, coll. P.G.; 6, Lake Mooat, 15 km E of Kotamubagu, 0°45'N 124°25'E, in coffee plantation, small pitfalls, 21-23 October 1985, coll. PG.

Remarks. These specimens are similar in colour pattern to those from Sumatra described in Yoshii (1989). The ventral tube has a row of minutely granulated streaks anteriorly together with larger ones on the basal half of the terminal tubule, the former arising from the distal border of the lateral flap (Fig. 3E). These structures can only be seen when the terminal tubule is extruded from the main body of the ventral tube. Chaetal pattern is somewhat variable. There are some specimens with more setae, although in the main elements, such as the anterior group of th II, III, setae of abd I, II and abd IV, there are no essential differences. These characteristics, the presence of dental spines and the absence of dental vesicles, place *C. sumatrana* in *Istanaphysa* rather than *Batikphysa*.

This species is apparently widely distributed, and it was observed to be common in the garden of at hotel in Sanur Beach, Bali.

Extralimital distribution. Sumatra, Bali (new record).

Microparonella annulicornis (Oudemans)

Sira annulicornis Oudemans, 1890: 87.
Paronella annulicornis - Schött 1903: 6.
Microparonella annulicornis - Yoshii 1981: 38.

Material examined. One specimen: 1, Dumoga Bone N.P., second waterfall, 0°35'N 123°54'E, Malaise trap, 25-28 September 1985, coll. P. Ashe.

Remarks. This example is typically patterned as in Yoshii (1983: 38) (Fig. 21A).

Extralimital distribution. Borneo, Sumatra, Java.

Bromacanthus setigerus (Börner)

Paronella setigera Börner, 1906: 178.
Bromocanthus setigerus - Yoshii 1981: 41.

Material examined. Eighteen specimens: 4, Dumoga Bone N.P., 200-300 m, 0°34'N 123°54'E, lowland forest, 16 October 1985, coll. PG; 5, same locality data, 14 October 1985, coll. PG; 6, 5.5 km NW Toraut dam, 0°34'N 123°54'E, 11 September 1985, coll. PG; 2, Toraut River banks, 0°34'N 123°54'E, 7 September 1985, coll. PG; 1, near Lake Mooat, 15 km east Kotamobagu, 1080 m, 0°45'N 124°25'E, 20-21 October 1985, coll. PG.

Extralimital distribution. Malay Peninsula, Sumatra, Java, Borneo.

Bromacanthus wallacei sp. n.
Fig. 5A - 1

Type material. HOLOTYPE - SAMA I22606, Dumoga Bone N.P., 300 m, 0°34'N 123°54'E, lowland rainforest, leaf litter, 9 September 1985, coll. PG.

PARATYPE - 1, 1,500 m, 0°35'N 123°52'E, rainforest, Dumoga Bone N.P., October 1985, coll. PG.

Additional material. Six specimens: 2 (MZB). Gunung Mogogonipa, 1000 m, 0°27'N 123°57'E, in moss and leaf litter, 24 September 1985, coll. PG; 4, Molibagu Road, 65 km SW Kotamobagu, south coast, 0°22'N 123°59'E, 19 September 1985, coll. PG.

Description. Body length about 1.8 mm, ground colour brownish white, with distinct patches (Fig. 5A), constant in all specimens at hand. Distinct pigmented patches arranged as follows: along the lateral margin of th II, III, on coxa of mid-leg, on the sides of abd III, and as a longitudinal stripe on abd IV. Legs often with narrow stripes along the sides. Ant I, II with distal patches, while ant III, IV are diffusely dark; other extremities pale. Antennae short, ant I:head being about 1:1. Ant I, II with scales. Labrum with setae 4/5, 5, 4, pre-labrals barbed, first row of setae longer, but not modified. Labral margin with two tubercles. Outer max lobe (Fig. 5C) with setae 2/II+3, but both basal and apical

seta of the papilla are short and not longer than the peripheral setae. Labial base (Fig. 5D) with setae MM(r)E/LL. Maxillary head rather reduced and its lamellae not radula-like. Eyes 8+8, G, H smaller and accompanied by three ciliated setae (Fig. 5B). Legs with scales for whole length to tip. Unguis (Fig. 5E) very slender and elongate, with one or two inner teeth, the proximal one very near the base. Unguiculus small, distinctly truncate. Tenent hair not clearly observed, possibly truncate distally. Trochanteral organ an assembly of *ca* 50 shiny setae arranged in a quadrangle. Femoral organ (Fig. 5F) present in usual form. Ventral tube unscaled, with many long, ciliated setae on both sides. Lateral flap bears both smooth and barbed setae. Terminal tubule is smooth. Furca with manidens as 10:13, both only scaled ventrally. Terminal thickening of manubrium strongly developed (Fig. 5H) and with 4+4 serrated terminal setae. Dorsal side only with barbed setae. Dens (Fig. 5G) bearing a row of small, smooth, spiny setae starting at the base continuing for 3/4 of the length of the dens, then gradually transforming into coarse barbed setae, which are broader near mucronal end. The dental spines accompanied by another row of minute spinules on the ventral side. Mucro small, bidentate and obscurely separated from dens (Fig. 5I). Setae of the clypeal area all barbed. Setae of the frontal area composed of f-0, f-1 and L plus the subantennal setae, as already seen in other species of the genus. Body surface with very small, hyaline scales and no macrosetae.

Remarks. The species is dedicated to A.R. Wallace, a pioneer of zoological research in the region. From the setae of the labial base, *B. wallacei* is near *B. flavidulus* Yoshii, 1981, of Borneo, but is quite different in colour pattern.

Extralimital distribution. None.

Cyphoderus javanus Börner

Cyphoderus javanus Börner, 1906: 180.
Cyphoderus borneensis - Yoshii 1980: 3.

Material examined. More than thirtysix specimens: about 30, Komangaan Cave, 18 km W Kotamobagu, 0°54'N 124°24'E, 24 October 1985, coll. PG; 2 (MZB) same locality, 14 September 1985, coll. PG; 2, Gunung Mogogonipa, 1000 m, 0°27'N 123°57'E, 24 September 1985, coll. PG; Dumoga Bone N.P., 0°34'N 123°54'E, 17-22 September 1985, 25

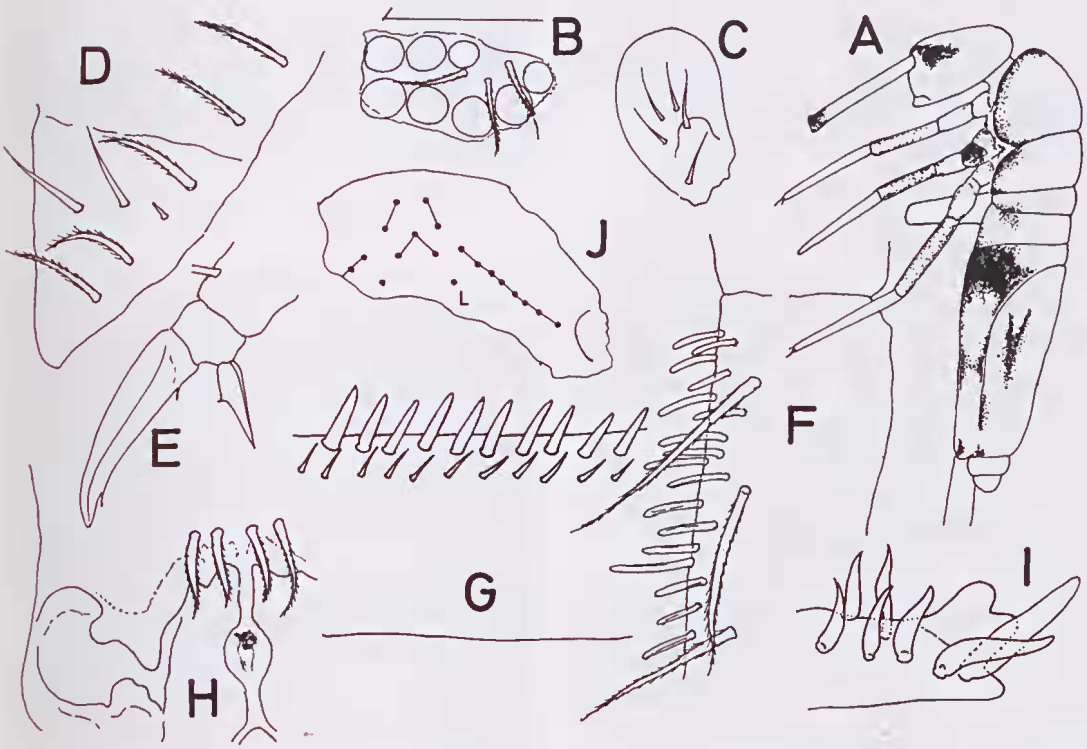

Fig. 5. *Bromacanthus wallacei* sp. n.: **A**, habitus; **B**, ocelli; **C**, outer maxillary lobe; **D**, labial base; **E**, mid-claw; **F**, femoral organ; **G**, dental setae; **H**, manubrial terminal thickening; **I**, mucro; **J**, chaetal pattern of frontal area.

October 1985, coll. PG; 2, Toraut River banks, 0°34'N 123°54'E, garden, edge of forest, 20-25 September 1985, coll. PG.

Extralimital distribution. Java, Borneo.

Serroderus hozawai (Kinoshita)

Cyphoderus hozawai Kinoshita, 1917: 41.
Setoderus hozawai - Yoshii 1980: 8.

Material examined. Sixteen specimens: 16, Dumoga Bone N.P., Edwards Camp, 5.5 km NW Toraut Dam, 0°35'N 123°51'E, termite nest, 2 October 1985, coll. PG.

Remarks. The specimens are relatively small (about 1.2 mm) and may be juvenile. *Setoderus* was synonymised with *Serroderus* by Yoshii (1987: 123).

Extralimital distribution. Sumatra, Japan, Phillipines, Borneo.

Serroderus cf. *sabahnus* Yoshii

Setoderus sabahnus Yoshii, 1980: 5.

Material examined. About seven specimens: about 7, Dumoga Bone N.P., Edwards Camp, 5.5 km NW Toraut Dam, 0°35'N 123°51'E, termite nest, 2 October 1985, coll. PG.

Remarks. As all of the specimens are very small, about 0.8 mm, it is not possible to identify the species confidently. The four-toothed mucro is identical to that of the Bornean type.

Extralimital distribution. Borneo.

Mimoderus saikehi Yoshii

Mimoderus saikehi Yoshii 1980: 13.

Material examined. Thirty-two specimens: 32, Dumoga Bone N.P., Edwards Camp, 0°35'N 123°51'E, termite nest, 2 October 1985, coll. PG.

Remarks. These specimens are also smaller than the typical form, the body length being about 1.4 mm.

Extralimital distribution. Borneo.

HABITAT PREFERENCES AND ENDEMISM

One species, *Salina borneensis*, was collected in pitfalls in a garden near the Toraut River and seems to be a ground-living specialist which is unusual in the genus. This species has also been found only in ground collections on Christmas Island (Greenslade and Yoshii unpublished results) where a number of other *Salina* species were abundant on foliage.

Half (52%) of the collections came from 200-300 m altitude in the Dumoga Bone National Park in lowland rainforest near the Toraut and Tumpah Rivers. A further 25 (46%) collections were taken from sites between 500 m and 1780 m altitude. Among the 13 species for which there are more than single records, seven occurred both at low and high altitudes, including *B. wallacei* which is endemic to Sulawesi. Three species were found only at low altitudes, *C.* sp. cf. *apiana, S. borneensis* and *S. greensladeae*, none of which are endemic. Of the remaining three, *C. gapudi, C. sulawesica* and *C. incolorata*, two of which are endemic, all appear to be restricted to altitudes above about 500 m. These observations suggest that levels of local endemism in paronellids are higher at higher altitudes.

A similar pattern of endemism is present in the Orchesellini from Sulawesi (Mari Mutt 1987). Three species were recorded from northern Sulawesi, of which one from Dumoga Bone National Park lowland rainforest at 200-300 m was previously recorded from Indonesia, the Philippines, Micronesia and Hawaii. The other two species were new and are apparently endemic. One was found at Lake Mooat and neighbouring localities at altitudes of 1000 m and higher, and the other occurred in Dumoga Bone National Park and on Gunung Mogogonipa at altitudes above 1000 m at both localities.

BIOGEOGRAPHY

Of the sixteen paronellid species recorded here, all but one, *Salina celebensis*, are new records for Sulawesi. Five of the species are known to be endemic to Sulawesi, although little can be said about the unidentified *Salina* spp. A and B. One species occurs also in the Philippines and one on Bali and Sumatra. The remaining nine Paronellidae occur elsewhere in the Indian Ocean, Malaysia and Indonesia west of Sulawesi. At specific level, the greatest affinity of the Sulawesi paronellid fauna is with faunas from Borneo. The four cyphoderid species have similar distributions to this. All occur also on Borneo and elsewhere, but exclusively in the Oriental region. None of the Sulawesi species has been recorded as yet to the east from the Moluccas, Melanesia or Australia.

A similar geographical pattern is seen at the generic level. Of the genera recorded, two, *Microparonella* and *Salina*, are widely distributed and are pantropical or nearly so. *Bromacanthus* and *Callyntrura* seem to be restricted to southeast Asia (Suhardjono 1991), although *Bromocanthus* may occur in Papua New Guinea (Yoshii, unpublished results). However, the faunas of some territories and islands in the region are not at all well known. The distribution of collembolal faunas on Sulawesi conforms to Weber's, rather than Wallace's, line.

In summary, for both families, the northern Sulawesi fauna has Oriental affinities, with the closest relationship at species level withtaxa from the nearest major island, Borneo. The island of Sulawesi is considered to be composite in origin, partly formed from Asian crustal blocks and partly from terranes rifted from northwest Gondwana (Burrett *et al.* 1991). It is believed that the northern arm, from which these collections came, supports a fauna which is Oriental in origin. This is consistent with the distributional patterns observed in the Collembola.

ACKNOWLEDGEMENTS

This paper is based on material collected during Project Wallace sponsored by the Royal Entomological Society of London and the Indonesian Institute of Sciences (Results of Project Wallace No. 132). Thanks are due to the Australian Biological Resources Survey for supporting the work.

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Accepted 30 April 1992